Project Report: Biochemistry of Archaea and Bacteria: Biochemistry of Psychrophillic Organisms

Lead Team:	***Pennsylvania State University***
Project Title:	***Biochemistry of Archaea and Bacteria: Biochemistry of Psychrophillic Organisms***
Project Investigator:	***Jean Brenchley***

Project Progress

We study the diversity of psychrophilic (cold−loving) microorganisms as models for the possible origin, evolution, and survival of organisms from other cold, non−terrestrial sources. Interesting results were obtained this year during our analysis of the microbial diversity of an ice core taken from a > 200,000 year old Greenland glacier. We inoculated a sterile, melted sample into anaerobic media designed for autotrophic organisms and incubated cultures for several months at minus 2°C. Microscopic examination demonstrated the growth of many unusually shaped organisms that we characterized in two ways. First, DNA was extracted from the community and the rRNA genes polymerase chain reaction (PCR) amplified. The individual genes were cloned, purified, sequenced, and compared. We aligned 25 sequences representing a wide physiological diversity, including Gram positive anaerobic rods and cocci and alpha, beta, and gamma Proteobacteria. Our second approach cultivated several hundred aerobic isolates, many with pigmented and different colony morphologies. We amplified, cloned, and aligned rRNA gene sequences for 28 of these isolates. Phylogenetic analyses showed representatives from many different physiological groups. Of special interest was the finding of two isolates, a *Brevundimonas* and a *Stenotrophomonas*, with rRNA gene sequences corresponding to ones obtained from the direct DNA extraction approach. Several conclusions derive from these results. A rich, viable, microbial diversity was preserved in the >200,000 year old ice core. The molecular analysis of both the extracted DNA and the isolates provided a more complete picture of diversity than either alone. Many rRNA genes differed from known sequences, and they may represent the discovery of novel genera. Some of the organisms may have evolved unique survival strategies because only a few are related to known spore−forming bacteria. Further studies of these isolates are important for understanding the possible existence and survival of organisms on Mars and Europa.

Highlights

- A wide diversity of viable microorganisms has been found in a >200,000 year old Greenland glacier ice core. The molecular analysis of both extracted DNA and isolates obtained from a community provided a more complete understanding of the diversity than either method alone.

- Further studies on the survival strategies and growth characteristics of these isolates will be important for understanding the possible existence and survival of organisms elsewhere in the solar system.

Roadmap Objectives

- ***Objective No. 3:*** Models for Life
- ***Objective No. 6:*** Microbial Ecology
- ***Objective No. 7:*** Extremes of Life
- ***Objective No. 8:*** Past Present Life on Mars

Mission Involvement

*Mission Class**	*Mission Name (for class 1 or 2) OR Concept (for class 3)*	*Type of Involvement***
2,3	Mars Lander and future Mars/ Europa missions	Background research

* Mission Class: Select 1 of 3 Mission Class types below to classify your project:
1. Now flying OR Funded & in development (e.g., Mars Odyssey, MER 2003, Kepler)
2. Named mission under study / in development, but not yet funded (e.g., TPF, Mars Lander 2009)
3. Long−lead future mission / societal issues (e.g., far−future Mars or Europa, biomarkers, life definition)

** Type of Involvement = Role / Relationship with Mission
Specify one (or more) of the following: PI, Co−I, Science Team member, planning support, data analysis, background research, instrument/payload development, research or analysis techniques, other (specify).